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Does ABO Blood Type Implicate Susceptibility to Respiratory Abnormalities? A Controlled Cross-sectional Study among Indigenous University Students in Rivers State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. The study was conceptualised by authors AJN and VI. Data procurement was done by authors EBU, TAK and KBE. Data processing and analysis was done by authors AJN and AN while the manuscript was written by authors AJN and AN. All authors read and approved the final draft of the manuscript.

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ABSTRACT

Background: The blood typing is a genetically defined immune system characteristic that has a well-known role in transplantation and chemotherapy. However, it is unclear what role it could serve in diagnosing or predicting respiratory pathologies. The study aims at investigating the prevalence of respiratory disorder among ABO blood type. This study investigated the prevalence of respiratory disorder among ABO blood types.
Methods: Using a quantitative survey research design, this cross-sectional study comprises of 102 young University students (64 females and 36 males) within the age of 17-28 years, extracted from different local Government Area in Rivers State. A semi-structured questionnaire was used to gather the social demograpgic characteristics of respondent's. Anthropometric investigations and respiratory function test was done.
Results: The prevalent blood types A, B, O, and AB was 19.6%, 16.7%, 56.9%, and 6.9% respectively. BMI showed that 2.9%, 39.2%, 38.2% and 19.6% was underweight, normal weight, overweight and obese respectively. Respiratory problems were distributed unevenly among blood types, with risk of obstructive pulmonary dysfunction having the highest frequency of occurrence.
Conclusion: The susceptibility to respiratory abnormalities is not associated with any blood type, the risk of obstructive pulmonary disease is higher in blood type O, which is largely influenced by the predominancy.

Keywords: ABO blood type; pulmonary dysfunction; Spirometry; obstructive pulmonary disease; restrictive pulmonary disease.

1. INTRODUCTION

Respiratory disease is a leading cause of death and morbidity in developed countries [1]. However, the prevalence of respiratory disease in most developing nations, including Nigeria, is mainly unknown due to poor data management; nonetheless, the prevalence of infectious and non-infectious respiratory disease appears to be increasing [2]. The most common chronic respiratory disorders are chronic obstructive pulmonary disease (COPD) and asthma, both of which involve inflammation in the lower airways, resulting in bronchial obstruction [3]. In Europe, respiratory disorders are the third biggest cause of death. For example, in 2015, Poland's yearly COPD death rate was 52.1 per 100,000 inhabitants [4]. According to Joshi *et al.,* [5], chronic obstructive pulmonary disease (COPD) affects roughly 210 million people worldwide, with 3 million people dying each year. COPD has been ranked as the world's third leading cause of death [5]. According to estimates, millions of Nigerians suffer from respiratory problems, but up to 80% of them are undiagnosed. Some COPD instances develop later in life as a result of persistent asthma, which impairs health and makes the therapeutic procedure more difficult [6]. Asthma, unlike COPD, frequently begins in the first few years of life, although its severity does not fluctuate much over time [7]. Respiratory dysfunction has become more common in Nigeria over time as a result of indiscriminate emissions of many environmental toxicants that have a deleterious impact on respiratory functioning [8].

Respiratory illness incidence is determined by genetic predisposition as well as environmental variables such as allergens that promote asthma development, cigarette smoke, and atmospheric air pollution are the most common cause of COPD [9,10]. Other factors that contribute to the emergence of these illnesses include socioeconomic problems, particularly poverty and hunger, as seen by significant weight loss [11]. Apart from environmental factors, genetic predisposition may be at the root of a rise in the global incidence of respiratory dysfunction [12]. However, having a specific blood type could be one of the potential genetic risk factors. The frequency of A and B blood types differs between populations, as Ward *et al.,* [13] demonstrated. This finding has served as a springboard for

further research into the link between ABO blood groups and illness susceptibility [14,15]. On the extracellular surface of the erythrocyte membrane, housed the ABO blood type antigens, a complex carbohydrate molecules as described by Karl Landsteiner. Apart from expression on erythrocytes, these antigens are highly expressed on the surfaces of a variety of human cells and organs, including epithelium, sensory neurons, thrombocytes, and vascular endothelium. The ABO blood groups have clinical significance that extends beyond transfusion medicine. Abegaz *et al.,* [16] have suggested that this system has a role in the development of cardiovascular, oncological, and other illness disorders. In some groups, the ABO blood type system may be a hereditary factor linked to chronic respiratory illness risk [17,18]. Lampalo *et al.* [19] studied the blood types of children and adults with asthma and discovered that blood types A and B are linked to various atopic conditions. According to Sobkowiak *et al.* [20], asthma and allergic rhinitis share similar immunopathologic mechanisms, implying that the two diseases are manifestations of a single syndrome with a wide range of severity. Long *et al.* [21] have suggested that genetic and environmental determinants of asthma also entail greater vulnerability to allergic rhinitis. The majority of studies on the impact of blood type on the risk of chronic respiratory disorders were published before 2000, and the most current findings focus on children asthma, which is one of the most frequent chronic childhood diseases [22]. In people with asthma, Abegaz [16] found a substantial difference in the frequency of ABO blood types and corresponding secretory phenotypes. However, similar data was found for COPD, indicating that the absence of blood type B and the prevalence of type A are associated to COPD in white people [23]. Other investigations have found that adult patients with various atopic diseases have a higher frequency of A and B erythrocyte morphologies than the control groups [24. Additionally, the O blood type has been linked to asthma in Taiwanese and Italian infants [25], as well as adult Europeans [26-28]. However, evidence of a link between blood types and respiratory dysfunction susceptibility is insufficient to draw firm conclusions; this study is aimed at investigating the possibility of a link between ABO blood group and the occurrence of respiratory dysfunction among university students who are indigenes of Rivers State, Nigeria

2. MATERIALS AND METHODS

2.1 Participant

This study adopted an experimental study design, the sample size of the students was obtained using the formula for sample size for a cross-sectional study.

$$Sample\ size = \frac{Z_{1-\propto/2^2}\ p(1-p)}{d^2}$$

Where $Z_{1-\propto/2}$ = Standard normal variate (at 5% type 1 error) = 1.96

p = expected proportion of respondents (44%)
d = absolute error = 0.05

$$Sample\ Size = \frac{1.96^2 \times 0.44(1-0.85)}{0.05^2} = 101.42$$

For the purpose of this study, we rounded up the sample size to 102. Consented participants were drawn from different Local Government Areas (LGA) of Rivers State, Nigeria. One hundred and two (102) young adults (36 males and 66 females) with age range of 17-26years participated in this study. The results were compiled and analysed at the Department of Physiology Laboratory, PAMO University of Medical Sciences, Port-Harcourt, Rivers State, Nigeria. The study received approval from the University's research ethics committee (PUMS-REC/2021/038).

2.2 Criteria for Inclusion and Exclusion

The study excluded smokers, and alcoholics Individuals.

2.3 Questionnaire on Health Status

A modified version of the Healthy life Questionnaire was given to the participants. The goal of the survey was to learn about the participants' health status and life style.

2.4 Anthropometric Information

A measuring tape and a weighing scale were used to obtain the height and weight of participants, respectively. The body mass index (BMI) was computed by dividing the height (squared) and weight according to the formula:

$$BMI = \frac{\text{Weight (kg)}}{(\text{Height})2(\text{m2})}$$

2.5 Spirometry

A portable Micro Loop digital spirometer (CareFusion UK 232 LTD) was used to evaluate lung capacities such as vital capacity (VC), forced vital capacity (FVC), Inspiratory capacity as well as Functional residual capacity. Lung volumes such as tidal volume, Expiratory reserved volume, Inspiratory reserved volume, forced expiratory volume (FEV_1) as well as Peak Expiratory flow rate was also measured automatically by the machine. The participants had been adequately trained for the lung function test. This was accomplished by having the participants breathe three times into the mouth piece, both violently and gently and the machine automatically computed the lung function parameters and it is printed out with the help of a printer connected to the machine.

2.6 Blood Group Measurement

Antigen and antibody reactions were used to define the ABO blood group. A crimson suspension was generated by mixing 1ml of normal saline with two or three drops of blood from a finger puncture in a tiny test tube. A drop of anti-serum and a drop of red cell suspension were added to each blood grouping slide as labelled, and the combination was gently rocked in a circular motion for about 10 minutes until agglutination was visible.

2.7 Statistical Analysis

The data was analysed using a two-way ANOVA in SPSS version 22 and expressed as mean and frequency. $P< 0.05$ was considered significant. For correlation analysis, Pearson Chi-square was utilized.

3. RESULTS

3.1 Demography of Study Population

In Table 1, among the total population of 102 respondents, female was observed to be 64.7% and male 35.3%. The age was categorized into classes and the highest frequency was observed in age interval of 17-18years and was followed by 19-20years and 21-22years. The age interval of 23-24 and 27-28 was least (1%) while there was no respondent in the age interval of 25-26years. 39.2% of the total population was seen to have normal BMI value and 38.2% overweight while 19.6% was obese though the least frequency was seen with respondents with underweight (2.9%). Different blood group was tested; blood group A, B, O and AB was 19.6%, 16.7%, 56.9% and 6.9% respectively.

Table 1. Demography of respondent

Demography		Frequency/Percentage
Gender	Female	66(64.7%)
	Male	36(35.3%)
Age range	17-18	46(45.1%)
	19-20	36(35.3%)
	21-22	18(17.6%)
	23-24	1(1.0%)
	25-26	0(0.0%)
	27-28	1(1.0%)
Body mass index	Underweight	3(2.94%)
	Normal	40(39.22%)
	Overweight	39(38.23%)
	Obese	20(19.61%)
Blood type	A	20(19.61%)
	B	17(16.67%)
	O	58(56.86%)
	AB	7(6.86%)

Table 2. Frequency of ABO blood group and respiratory parameters below physiological range

	A	B	O	AB	X^2	*p*-value
Tidal volume	3 (15.0%)	3 (17.6%)	2 (3.4%)	0 (0.0%)	6.43	0.37
Expiratory reserved volume	9 (45.0%)	12(70.6%)	33(56.9%)	2 (28.6%)	7.43	0.28
Inspiratory reserved volume	16(80.0%)	10(58.8%)	46(79.3%)	4 (57.1%)	8.38	0.21
Inspiratory capacity	14(70.0%)	7 (41.2%)	41(70.7%)	1 (14.3%)	21.25	0.002*
Vital capacity	14(70.0%)	7 (41.2%)	41(70.7%)	1 (14.3%)	6.29	0.08
Functional residual capacity	10(50.0%)	9 (52.9%)	30(51.7%)	1 (14.3%)	8.65	0.36
Functional vital capacity	18(90.0%)	17(100.0%)	52(89.7%)	6 (85.7%)	16.22	0.01*
Force expiratory volume	2 (10.0%)	3 (17.6%)	3 (5.2%)	1 (14.3%)	7.26	0.29
Peak Expiratory flow rate	14(70.0%)	14 (82.4%)	28(48.3%)	2 (28.6%)	11.51	0.07
FEV/FVC	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	6.29	0.09

**p<0.05 is considered significant, A, B, O and AB represents blood type. X^2 represents chi-square, below physiological range (IRV; <3, IC;<3.5, VC; <4.5, FRC, <2, FVC; <4.5, FEV; <1.5, PER;<400, TITTOT;<40, TV/TI;<0.3 and FEV/FVC; <30)*

Table 3. Frequency between ABO blood group and respiratory parameters within physiological range

	A	B	O	AB	X^2	*p*-value
Tidal volume	6 (30.0%)	6 (35.3%)	18 (31.0%)	2 (28.6%)	6.43	0.37
Expiratory reserved volume	11(55.0%)	4 (23.5%)	24 (41.1%)	5 (71.4%)	7.43	0.28
Inspiratory reserved volume	4 (20.0%)	6 (35.3%)	12 (20.7%)	3 (42.9%)	8.38	0.21
Inspiratory capacity	6(30.0%)	4 (23.5%)	11 (19.0%)	5 (71.4%)	21.25	0.002*
Vital capacity	0 (0.0%)	0 (0.0%)	1 (1.7%)	1 (14.3%)	6.29	0.08
Functional residual capacity	9 (45.0%)	5 (29.4%)	23 (39.7%)	4 (57.1%)	8.65	0.36
Functional vital capacity	2 (10.0%)	0 (0.0%)	6 (10.3%)	0 (0.0%)	16.22	0.01*
Force expiratory volume	5 (25.0%)	1 (5.9%)	15 (25.9%)	0 (0.0%)	7.26	0.29
Peak Expiratory flow rate	6 (30.0%)	3 (17.6%)	27 (46.6%)	5 (71.4%)	1.21	0.97
FEV/FVC	0 (0.0%)	0 (0.0%)	1 (1.7%)	1 (14.3%)	6.29	0.09

**p<0.05 is considered significant, A, B, O and AB represents blood type. X^2 represents chi-square, normal physiological range, (IRV; 3-3.5, IC; 3.5-4, VC; 4.5-5, FRC, 2-2.4, FVC; 4.5-5, FEV; 1.5-1.8, PER;400-800, TITTOT;40-50, TV/TI; 0.3-0.6 and FEV/FVC; 30-50)*

Table 4. Frequency of ABO blood group and respiratory parameters above physiological range

	A	B	O	AB	X^2	*p*-value
Tidal volume	11 (55.0%)	8 (47.1%)	38(65.5%)	5 (71.4%)	6.43	0.37
Expiratory reserved volume	0 (0.0%)	1 (5.9%)	1 (1.7%)	0 (0.0%)	7.43	0.28
Inspiratory reserved volume	0 (0.0%)	1 (5.9%)	0 (0.0%)	0 (0.0%)	8.38	0.21
Inspiratory capacity	0 (0.0%)	6 (35.3%)	6 (10.3%)	1 (14.3%)	21.25	0.002*
Vital capacity	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	6.29	0.08
Functional residual capacity	1 (5.0%)	3 (17.6%)	5 (8.6%)	2 (28.6%)	8.65	0.36
Functional vital capacity	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (14.3%)	16.22	0.01*
Force expiratory volume	13 (65.0%)	13(76.5%)	40(69.0%)	6 (85.7%)	7.26	0.29
Peak Expiratory flow rate	0 (0.0%)	0 (0.0%)	3 (5.2%)	0 (0.0%)	1.21	0.97
FEV_1/FVC	20(100.0%)	17(100.0%)	57(98.3%)	6 (85.7%)	6.29	0.09

**p<0.05 is considered significant, A, B, O and AB represents blood type. X^2 represents chi-square, above physiological range, (IRV; >3.5, IC; >4, VC; >5, FRC, >2.4, FVC; >5, FEV; >1.8, PER; >800, TITTOT; >50, TV/TI; >0.6 and FEV/FVC; >50*

3.2 Frequency of ABO Blood Type and Respiratory Parameters below Physiological Range

The prevalence of respondents with respiratory parameters below physiological range and their blood group was presented in Table 2. In a population of 102 respondents, among blood group A, B, O and AB, indicate that Tidal volume (TV), Expiratory Reserved Volume (ERV) and Inspiratory Reserved Volume (IRV) had [15.0%, 17.6%, 3.4% and 0.0%], [45.0%, 70.6%, 56.9% and 88.6%] and [80.0%, 58.8%, 79.3% and 57.1%] respectively. Similarly, among blood group A, B, O and AB, Inspiratory capacity (IC) had [70.0%, 41.2%, 70.7% and 14.3%], Vital capacity (VC) [70.0%, 41.2%, 70.7% and 14.3%], Functional Residual Capacity (FRC) had [50.0%, 52.9%, 51.7% and 14.3%] and Functional Vital Capacity (FVC) had [90.0%, 100.0%, 89.7% and 85.7%] respectively. More so, among blood group A, B, O and AB, Forced Expiratory volume (FEV) had [10.0%, 17.6%, 5.2% and 14.3%], Peak Expiratory Flow Rate (PEFR) had [70.0%, 82.8%, 48.3% and 28.6%] and FEV/FVC ratio had [0.0%, 0.0%, 0.0% and 0.0%] respectively as shown in Table 2.

3.3 Frequency of ABO Blood Type and Respiratory Parameters within Physiological Range

The prevalence of respondents with respiratory parameters within physiological range and their blood group is presented in Table 3. In a population of 102 respondents, among blood group A, B, O and AB, it was observed that Tidal volume (TV), Expiratory Reserved Volume (ERV) and Inspiratory Reserved Volume (IRV) had [30.0%, 35.3%, 31.0% and 28.6%], [55%, 23.5%, 41.1% and 71.4%] and [20.0%, 35.3%, 20.7% and 42.7%] respectively. Similarly, among blood group A, B, O and AB, Inspiratory capacity (IC) had [30.0%, 23.5%, 19.0% and 71.4%], Vital capacity (VC) [0.0%, 0.0%, 1.7% and 14.3%], Functional Residual Capacity (FRC) had [45.0%, 29.4%, 39.7% and 57.1%] and Functional Vital Capacity (FVC) had [10.0%, 0.0%, 10.3% and 0.0%] respectively. More so, among blood group A, B, O and AB, Forced Expiratory volume (FEV) had [25.0%, 5.7%, 25.9% and 0.0%], Peak Expiratory Flow Rate (PEFR) had [30.0%, 17.6%, 46.6% and 71.4%] and FEV/FVC ratio had [0.0%, 0.0%, 1.7% and 14.3%] respectively as shown in Table 3.

3.4 Frequency of ABO Blood type and Respiratory Parameters above Physiological Range

The prevalence of respondents with respiratory parameters above physiological range and their blood group was presented in Table 4. In a population of 102 respondents, among blood group A, B, O and AB, Tidal volume (TV), Expiratory Reserved Volume (ERV) and Inspiratory Reserved Volume (IRV) had [55.0%, 47.1%, 65.5% and 71.4%], [0.0%, 5.9%, 1.7% and 0.0%] and [0.0%, 5.9%, 0.0% and 0.0%] respectively. Similarly, among blood group A, B, O and AB, Inspiratory capacity (IC) had [0.0%, 35.3%, 10.3% and 14.3%], Vital capacity (VC) [0.0%, 0.0%, 0.0% and 0.0%], Functional Residual Capacity (FRC) had [5.0%, 17.6%, 8.6% and 28.6%] and Functional Vital Capacity (FVC) had [0.0%, 0.0%, 0.0% and 14.3%] respectively. More so, among blood group A, B, O and AB, Forced Expiratory volume (FEV) had [65.0%, 76.5%, 69.0% and 85.7%], Peak Expiratory Flow Rate (PEFR) had [0.0%, 0.0%, 5.2% and 0.0%] and FEV/FVC ratio had [100.0%, 100.0%, 98.3% and 85.7%] respectively as shown in Table 4.

4. DISCUSSION

The working hypothesis of this study was that the occurrence of respiratory dysfunction was linked to ABO blood type. The findings, however, did not support this notion. The sole noteworthy discovery was that among people in Rivers state, Nigeria, non-A, B, and AB blood types, i.e. Type O (56.9%), predominated. A number of studies have shown that the distribution of blood types among different populations at different times is influenced by evolutionary selective pressure that modifies susceptibility to various diseases. The finest example is infectious diseases: the fact that the O blood type has a selection advantage against severe COPD possibly explains why this blood group is more prevalent in locations where malaria is common [29]. Other researchers have speculated that the unusually high incidence of B blood type in India, which has been linked to a reduced risk of COPD, could be linked to the selective pressure posed by the endemic infectious disease (Shokri et al., 2022). The immune system's blood phenotyping is determined by genetics and it is well-known for its role in transplantation and chemotherapy, but its potential role in diagnosing respiratory diseases, particularly those that are inflammatory

or infectious, is unknown. This present study explored the susceptibility of two plausible cases of respiratory abnormalities (below physiological range and above physiological range) and their possible link with ABO blood type. Among the blood types, type O and type A has the highest incidence of inspiratory capacity below the physiological range (70.7% and 70% respectively), blood type AB (71.4%) has the highest incidence of normal range while blood type B (35.3%) has the highest incidence of values above normal physiological range. The term "inspiratory capacity," or "IC," refers to a measurement of air volume that can be used to determine respiratory function or health. IC is a lung volume that is measured during a pulmonary function test and can be used to indicate how well the lungs are working mechanically. The levels are lowered in case of obstructive lung illness such as asthma and chronic obstructive pulmonary disease (COPD). Our observation is consistent with the findings of Pourali et al*.,* [30] who conducted a study in Taiwan, has demonstrated that blood type O is vulnerable to the occurrence of asthma. The researchers came to the conclusion that type O is linked to the development of environmental allergies in children. In contrast, Abbas et al*.,* [28] found no significant link between blood groups and asthma in the populations of Mysore, Karnataka, and South India. In this study, blood type AB was linked to a normal value of inspiratory capacity, implying that the risk of asthma and COPD is very low in this blood type. Furthermore, blood type B has the highest rate of IC outside of the normal physiological range. Marott and colleagues claim that IC is more effective than FEV_1 in determining the severity of COPD during an acute exacerbation [31]. COPD patients with an IC/TLC ratio of less than 25% are more likely to have unscheduled doctor visits owing to exacerbations or the requirement for closely monitored treatment, according to another study [32]. This is corroborated by the findings of Varol and colleagues who discovered that an IC/TLC ratio of less than or equal to 25% was a significant predictor of death in patients with emphysematous COPD [33].

The volume of air that can be expelled forcefully and quickly following a maximal or deep inspiration is known as functional vital capacity (FVC). It is a spirometrically assessed dynamic lung capacity. In this study, it was discovered that blood type AB has a 14.3% rise in FVC above the usual physiological range, but blood types A, B, and O (90%, 100% and 89% respectively) had FVC levels below the physiological limit. This variance may be due to the high prevalence of specific blood types in this location. Reduced TLC in individuals with spirometric signs of airway obstruction, such as RV above normal values or FEV_1 % below normal levels, may indicate mixed obstructive-restrictive lung disease (MORLD). Premature development of flow limiting segments and decreased pulmonary compliance both reduce FVC in MORLD. FVC reduction can sometimes outpace FEV_1 reduction, resulting in a greater FEV1 % [34]. This explains the findings of a research by Swanney et al., [35] which compared grading of airway obstruction based on FEV_1% (ATS recommendation) and FEV_1% (Intermountain Thoracic Society (ITS) recommendation). According to the findings of Halpin and colleague, the ATS suggestion classified 90% of 147 MORLD patients as having severe blockage, while the ITS recommendation classified only 3% of the same patients as having severe obstruction [36]. Another study found an inverse relationship between FEV_1% and RV/TLC in MORLD patients [37]. As a result, adjusting FEV_1 % for TLC reduction is anticipated to improve grading of obstruction severity in MORLD patients.

5. CONCLUSION

The findings of our study revealed that among the people of Rivers State, non-A, B, and AB blood types (type O) predominated, and that the susceptibility to respiratory abnormalities such as obstructive and restrictive pulmonary diseases is inconsistently prevalent among blood types. However, blood type O is more associated with susceptibility to obstructive pulmonary abnormalities compared to restrictive pulmonary abnormalities which was largely influenced by the frequency of occurrence. Though, blood type is not a predictive factor in determining whether obstructive or restrictive lung problems would emerge, further research on the predisposing role of ABO antigens in the development of respiratory disorders is needed. Nonetheless, understanding the possible link between ABO blood type and the pathophysiology of respiratory disorders might improve the ability to forecast their development.

CONSENT

As per international standard or university standard, Parental written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

The institution, PAMO University of Medical Sciences Research Ethics Committee approved this study with approval number PUMS-REC/2021/038. Informed written consent to participate was obtained from study participants.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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